TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during March 1940, classified according to t h potential temperatures (10° intervals between 290° and 409°A.) with which they are identified (based on radiosonde observations)*—Con.

Potential temperatures, °A	Miami, Fla.			Minneapolis, Minn.			Nashville, Tenn.			Oakland, Calif.			Oklahoma City, Okla.			Omaha, Nebr.			Pensacola, Fla.		
	Number of cases 4	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290–299				3	6.5	45.6							1	5.9	37.7						
300–309	1	7.2	36.0	9	8.1	48.8	1	8.2	50.0	1	8.2	46.0	1	7.4	43.3	10	7.8	46.6			
310–319	1	8.8	46.0	20	9.3	54.6	12	9.1	49.4	6	9.0	49.3	6	9.1	49.0	21	9.4	54.2	2	10.2	56.5
320–329	7	8.9	36.9	20	10.6	59.7	16	10.4	54.8	21	10.8	59.0	26	10.5	56.3	21	10.7	59.4	4	9.8	49.8
330–339	28	10.9	51.7	2	11.8	65.5	16	11.4	58.6	22	12.0	64.2	17	11.6	61.2	10	11.2	58.5	13	11.2	55.8
340–349	17	12.3	57.5				7	11.8	56.6	9	12.8	64.6	7	12.6	63.9	3	11.9	56.7	2	12.5	60.5
350–359	13	13.2	60.3				2	13.1	61.0	1	12.2	50.0				1	11.6	48.0	1	12.5	57.0
360–369	12	14.4	66.1										2	13.6	61.5	2	12.8	54.5			
370–379	7	15.2	67.9				1	13.8	60.0	2	14.4	62.0	2	14.4	61.0						
380–389	10	16.1	72.3				4	14.7	59.8	1	15.5	66.0	3	14.8	62.3	3	14.5	60.0			
390–399	6	16.8	72.2				3	14.9	58.3	1	15.6	66.0	3	15.6	64.0	2	15.5	60.0	1	16.2	72.2
400–409	6	17.3	73.8	1	14.2	52.0	2	16.4	66.0	5	16.1	63.2	5	16.6	67.4	2	15.4	58.5	1	17.9	79.0
Weighted means		13.1	59.4		9.6	55.4		11.3	56.0		11.9	60.8		11.7	58.7		10.5	55.7		11.5	53.0
Mean potential temperature °A. (weighted)		355.0			317.6			338.4			338.3			340.2			329.0			336.9	
Number days with observations		31			27			27			30			28			29			17	

Potential temperatures °A	Phoenix, Ariz.			St. Louis, Mo.			San Antonio, Tex.			San Diego, Calif.			Sault Ste Marie, Mich.			Spokane, Wash.			Washington, D. C.		
	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290–299													5	7.1	49.2	4	7.1	47.2			
300–309	2	6.4	32.5	4	8.3	49.8							18	8.0	49.9	8	8.4	51.9	5	7.9	47.6
310–319	5	9.1	48.2	15	9.3	52.8	3	8.2	37.0	1	8.4	39.0	28	9.6	57.6	20	9.2	52.8	13	9.5	54.4
320–329	14	10.8	55.5	20	10.8	59.0	13	10.2	51.9	10	10.8	58.3	6	10.4	59.0	27	10.9	62.1	7	10.2	55.9
330–339	17	11.6	59.4	8	11.4	61.1	27	11.3	55.3	9	11.7	61.2	1	12.4	70.0	7	11.7	63.6	4	11.6	62.0
340–349	6	12.4	60.5	1	12.7	66.0	14	12.3	59.4	7	12.7	64.1									
350–359	2	13.0	62.5	2	12.4	56.0	5	13.5	63.0	1	14.2	68.0									
360–369				1	12.9	59.0	5	13.9	60.6												
370–379	1	13.1	52.0	1	13.1	54.4	4	14.6	65.8				2	12.9	51.2						
380–389	1	14.7	59.0	2	14.0	57.5	4	15.4	66.2							1	13.9	55.0			
390–399	2	15.6	65.0	2	15.1	62.5	9	16.1	66.8	4	16.0	68.2									
400–409	2	16.2	64.5	4	16.0	61.8	6	16.4	66.3				1	15.7	62.2						
Weighted means		11.5	56.8		11.1	57.3		12.6	58.4		12.1	61.3		9.3	54.9		10.0	57.3		9.7	54.6
Mean potential temperature °A. (weighted)		337.4			334.4			350.8			340.6			315.6			318.9			318.2	
Number days with observations		26			26			31			16			28			28			19	

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD, in charge]

By BENNETT SWENSON

The outstanding features during March 1940, from the standpoint of floods, were: First, the occurrence of two major floods in the Sacramento Valley occurring within an interval of approximately a month. The first had its beginning the latter part of February and continued into the first week of March while the second began the latter part of March. A report of the first of these floods appears elsewhere in this REVIEW as a separate article; the second flood will be reported at a later date.

Second, the constant threat during the month of floods in the Northeast due to the presence of considerable snow on the ground. No appreciable flooding materialized until the last of the month when floods developed principally in the Susquehanna and Allegheny River basins.

A number of other floods occurred during the month but were mostly of light to moderate degree.

Precipitation during the month was generally considerably above normal in the upper Mississippi and middle Missouri basins, the central Rocky Mountain region, the Northeast, and the middle Pacific slope drainage area. Temperatures were below normal in the eastern half of the country and above normal in the western half.

St. Lawrence drainage.—Moderate flash floods occurred in the Red Cedar and Flint Rivers during the latter part of March. Persistent cold weather up to March 28 had prevented any appreciable run-off and the streams were abnormally low. A sharp rise in temperature on the 29th melted the remaining snow cover and started the break-up of ice in the streams. Sudden rises in the headwaters and ice jams caused moderate overflow in low places. No appreciable damage resulted but 2 lives were lost.

An ice gorge at Napoleon, Ohio, on the Maumee River, caused flooding when the river backed up to a stage of 13.4 feet at that place on March 5.

Slight flooding occurred on the Sandusky River on March 4–5.

Atlantic slope drainage.—Several rises occurred in the Delaware River Basin during the month resulting in some minor flooding with no appreciable losses.

There were three separate periods of high water in the Schuylkill River namely, on the 4th, 15th, and 31st. In the first period rainfall averaging about 1.25 inches over the basin, together with a snow cover of 3 to 4 inches and of heavy water content over northern portions of the basin, caused streams to rise rapidly but did not reach flood stage.

Heavy rain fell on the 14th and 15th, ranging from 1.50 inches in the south and west sections of the basin to 2.70 inches in the north and east. The river rose rapidly and crested at a stage of 14.2 feet at Reading, Pa., on March 15.

Again on the 30th, heavy rains this time ranging from 1.30 inches over southern portions to 2.30 inches over the northern portions occurred when streams were running high and the ground well soaked. The river approximately reached but did not exceed flood stage in this rise.

At the time of the last rise in the Schuylkill, mentioned above, stages in the Lackawaxen, the Lehigh, and the Delaware River at Trenton, N. J., exceeded flood stage slightly with only little actual damage.

During the first half of the month there was a general increase in the depth and density of the snow cover in the Susquehanna Basin, particularly over the northern portion. Measurements made on March 18 indicated an average snow depth of 16.1 inches and a water content averaging 6.41 inches over the basin above Towanda, Pa. The depth of snow on the ground on March 25 in that portion of the basin below Towanda averaged 6.4 inches.

Temperature conditions moderated on March 28 and heavy rains on the 31st resulted in a rapid rise in the upper portion of the basin to slightly above flood stage. The flooding spread over the lower basin and was one of a series of rises that continued into April; the first rise was generally the most severe of the several rises. A discussion of these floods will be given at a later date. It is interesting to note that after the rainstorm of March 31 the snow depth above Towanda was reduced to an average of 5.7 inches, but the water content still averaged nearly 4 inches.

Slight flooding occurred in the Cape Fear River at Elizabethtown, N. C., and in portions of the Savannah River on about March 17, but no appreciable damage was reported.

East Gulf of Mexico drainage.—Moderate to heavy precipitation over much of this drainage in the form of showers and thunderstorms on the 12th and 13th and rain on the 14th, resulted in some flooding.

Flood stage was exceeded in the Apalachicola River at Blountstown, Fla., where a crest stage of 18 feet occurred on March 19 with only slight damage due to suspension of business.

Moderate flooding in the Black Warrior and Tombigbee Rivers extended from the 13th to the 26th. No appreciable damage occurred in the Black Warrior, or in the Tombigbee above Demopolis, Ala. In the lower Tombigbee a total estimated loss of about $10,500 was reported.

A second and minor rise in the lower Pearl River followed closely the primary rise of February exceeding flood stage at Pearl River, La., by 0.8 foot on March 3. Flood stage was again reached during the month at Monticello, Miss., on March 31. Little damage occurred from these rises.

Upper Mississippi and Missouri Basins.—Ice in the upper Mississippi gradually decreased in thickness and considerable open water appeared by the middle of the month. The ice began moving out at La Crosse, Wis., and Dubuque, Iowa, on March 19, but was still frozen solid in the Lake Pepin area.

Stages in the Missouri continued low quite generally. At Omaha, Nebr., the stage was 2.1 feet on March 1, which is the lowest March stage of record and the mean for the month, 3.5 feet, was the lowest March mean of record.

Ohio River Basin.—The ice gorge that was present in the Allegheny River at Parkers Landing, Pa., during February remained at that point until about March 20 when it moved downstream several miles but still held at West Monterey, Pa., 5 miles below Parkers Landing. The water backed up behind the gorge reaching a stage of 24.9 at Parkers Landing on March 20.

Some additional snow fell over the Allegheny and Monongahela Basins during the first half of the month, but during the latter half there was a gradual decline of the snow depth over these basins except in the northern portion of the Allegheny Basin and over the eastern and southern rims of the Allegheny and Monongahela Basins where considerable snow remained.

Precipitation occurred on the 28th ranging from a trace over the upper Monongahela to over an inch in the middle Allegheny, and less than half an inch over the upper Allegheny. Some of the precipitation was in the form of snow in the higher elevations. The rivers showed small rises on the 29th. On March 30 additional precipitation occurred, ranging from half an inch in the upper Allegheny to 2.25 inches in the central basins and 1.50 inches in the upper Monongahela. About 3 inches of water in the form of snow was present in the upper Allegheny of which about 2 inches melted on March 30–31. A rise resulted in the Allegheny which was the first of a series that continued in April, and, as in the Susquehanna, was the greater rise. The crest stage reached at Pittsburgh in this first rise was 28.5 feet at 10 p. m., March 31. The flood will be discussed at greater length in connection with the later rises at a later date.

Minor rises occurred in a few other tributaries of the Ohio River with slight flooding occurring. The principal rises were in the Scioto River from the 3rd to the 6th, the Little Kanawha, which was slightly above flood stage at Glenville, W. Va., on March 31; the Wabash, which was in moderate flood at points between Bluffton and Terre Haute, Ind., from March 3 to March 7; the Cumberland River, which reached flood stage at Celina, Tenn., on March 31; and the Green River, which exceeded flood stage slightly at Woodbury, Ky., on March 4.

In the Ohio River proper, except for the flooding in the extreme upper reach in the vicinity of Pittsburgh on the last of March, flood stage was exceeded during the month only in the lower portion in the vicinity of Shawneetown, Ill. That station and Dams 47 and 50 reported above flood stages from March 8 to 18, but no losses were reported.

Lower Mississippi Basin.—Slight flooding occurred in the St. Francis River where a crest stage of 22.4 feet was reached at Fisk, Mo., on the 15th. Otherwise the stages in the lower Mississippi and the larger tributaries remained at low levels.

Pacific Slope drainage.—The flood that occurred in the Sacramento Valley late in February developed into one of first magnitude, exceeding that of December 1937 and in some respects surpassed any flood since systematic records have been kept by the Weather Bureau. The total damage for the Sacramento and lower San Joaquin

drainage area in this flood has been estimated at about $6,700,000. A report on the features of the flood appears on pages 71–74 in this REVIEW.

Another major flood was developing in the Sacramento Basin at the close of the month, report of which will be made at a later date.

Slight flooding was reported in the Eel River, the river cresting at a stage of 18 feet at Fernbridge, Calif., on March 30, and in the Long Tom River where two rises occurred, the first reaching a stage of 13 feet on March 1 and the second, 11.4 feet on March 30, both at Monroe, Oreg.

Table of flood losses—March 1940

Drainage and river	Lives lost	Tangible property	Matured crops	Prospective crops	Live stock and other movable farm property	Suspension of business	Total monetary loss
St. Lawrence: Red Cedar	2						
East Gulf of Mexico: Apalachicola						$1,000	$1,000
Tombigbee		$3,850			$1,500	5,200	10,550
Ohio Basin: Green River in Kentucky		1,000					1,000
Pacific Slope: Sacramento River [1]	2	2,685,314	$600,020	$2,701,630	569,440	174,650	6,731,054

[1] Feb. 27–Mar. 6.

Table of flood stages during March 1940

[All dates in March, unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ST. LAWRENCE DRAINAGE					
Lake Michigan					
Red Cedar:	*Feet*			*Feet*	
Williamston, Mich	6	30	(1)	7.2	30
East Lansing, Mich	8	30	31	8.6	30
Lake Huron					
Flint: Columbiaville, Mich	8	31	Apr. 5	10.1	Apr. 1
Pine: Alma, Mich	6	29	30	6.9	29
		Apr. 1	Apr. 2	6.4	Apr. 1
Lake Erie					
St. Marys: Decatur, Ind	13	3	7	17.3	4
Maumee: Napoleon, Ohio	10	5	6	13.4	5
Sandusky:					
Upper Sandusky, Ohio	13	3	4	14.1	4
Tiffin, Ohio	7	5	5	7.0	5
ATLANTIC SLOPE DRAINAGE					
Lackawaxen: Hawley, Pa	9	31	Apr. 1	12.5	31
Lehigh: Lehighton, Pa	9	31	Apr. 1	11.6	31
Schuylkill: Reading, Pa	11	15	15	14.25	15
Neuse: Smithfield, N. C	13	16	18	14.0	16–17
Cape Fear: Lock No. 2, Elizabethtown, N. C	20	16	18	22.6	17
EAST GULF MEXICO DRAINAGE					
Apalachicola: Blountstown, Fla	15	16	24	18.0	19
Black Warrior:					
Lock No. 10, Tuscaloosa, Ala	46	14	16	50.4	15
Lock No. 7, Eutaw, Ala	35	15	20	40.5	18

Table of flood stages during March 1940—Continued

[All dates in March, unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
EAST GULF MEXICO DRAINAGE—con.					
Tombigbee:	*Feet*			*Feet*	
Lock No. 4, Demopolis, Ala	39	15	23	46.1	20
Lock No. 3, Whitfield, Ala	33	(2)	2		
		15	25	47.9	20
Lock No. 2, Pennington, Ala	46	17	23	49.0	21
Lock No. 1, Ala	31	(2)	4		
		17	26	34.0	23
Pearl:					
Monticello, Miss	15	31	31	15.0	31
Pearl River, La	12	(3)	5	[3] 12.8	3
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
Zumbro: Theilman, Minn	35	31	(1)	36.4	31
Ohio Basin					
Allegheny:					
Red House, N. Y	10	31	31	10.2	31
Parkers Landing, Pa	20	20	22	24.9	20
Lock No. 8, Mosgrove, Pa	24	31	31	25.0	31
Lock No. 5, Schenley, Pa	24	31	(1)	31.8	31
Lock No. 4, Natrona, Pa	24	31	(1)	29.7	31
Lock No. 3, Acmetonia, Pa	25	31	(1)	29.9	31
West Fork of Monongahela: Clarksburg, W. Va	5	31	31	6.0	31
Youghiogheny: Connellsville, Pa	13	31	31	13.2	31
Little Kanawha: Glenville, W. Va	23	31	31	23.6	31
Little Sandy: Grayson, Ky	15	31	31	18.5	31
Scioto:					
Larue, Ohio	11	2	5	14.3	3
Prospect, Ohio	10	4	6	12.2	5
Chillicothe, Ohio	16	4	6	19.0	5
Licking: Falmouth, Ky	28	3	3	28.8	3
Green: Lock No. 4, Woodbury, Ky	33	3	4	34.4	4
Wabash:					
Wabash, Ind	12	3	5	17.4	4
La Fayette, Ind	11	4	6	16.5	5
Covington, Ind	16	5	7	18.1	6
New: New River, Tenn	18	30	30	18.3	30
Cumberland: Celina, Tenn	28	31	(1)		
Ohio:					
Pittsburgh, Pa	25	31	Apr. 2	28.5	31
Dam No. 47, Newburgh, Ind	38	8	11	38.2	9–10
Shawneetown, Ill	33	8	13	34.1	11–12
Dam No. 50, Fords Ferry, Ky	34	8	14	36.0	11–12
Red Basin					
Sulphur: Ringo Crossing, Tex	20	30	30	21.1	30
Lower Mississippi Basin					
St. Francis: Fisk, Mo	20	14	16	22.4	15
WEST GULF OF MEXICO DRAINAGE					
Rio Grande: Mercedes, Tex	21	27	27	21.0	27
PACIFIC SLOPE DRAINAGE					
San Joaquin Basin					
Mokelumne: Bensons Ferry, Calif	12	Feb 28	1	13.3	Feb. 29
Sacramento Basin					
Stony Creek: St. John, Calif	12	Feb. 28	Feb. 28	13.9	Feb. 28
North Fork of Yuba: Colgate, Calif	14	26	26	14.6	26
		30	30	15.3	30
Feather:					
Oroville, Calif	25	Feb. 27	Feb. 28	25.1	Feb. 28
Nicolaus, Calif	25	Feb. 28	1	26.3	Feb. 29
Sacramento:					
Kennett, Calif	25	Feb. 27	Feb. 29	36.3	Feb. 28
Red Bluff, Calif	23	Feb. 27	1	32.2	Do.
Hamilton City, Calif	20	Feb. 28	1	22.6	Feb. 29
Colusa, Calif	28	Feb. 29	2	29.5	1
Knights Landing, Calif	30	Feb. 28	6	34.0	1
Humboldt Bay Basin					
Eel: Fernbridge, Calif	17.5	30	30	18.0	30
Columbia Basin					
Long Tom: Monroe, Oreg	10	Feb. 27	5	13.1	Feb. 29–Mar. 1
		28	(1)	11.4	30

[1] Continued at end of month.
[2] Continued from preceding month.
[3] Secondary crest, primary on preceding month.